Methodology of the Oklahoma Materials Inventory Research Project

MITCHELL D. SMITH, Geologist and Project Engineer, Oklahoma Department of Highways

The known supply of quality aggregates in Oklahoma is very limited and is rapidly becoming exhausted in many localities. This paper describes the methodology used to locate new sources of materials and to determine the quantity of materials available from previously known sources and from potential sources located during the inventory project. Basic steps of the inventory studies include (a) library study (the assembling of existing records of previously located material sources); (b) process of existing data (the listing and publishing of previously located potential material sources); (c) field data and sampling (including familiarization courses, preliminary field investigations and establishing of procedures and schedules); (d) laboratory testing and analysis of materials; and (e) consolidation of data and final report. Approximately one-third of the State has been surveyed since the project was initiated in 1958, and preliminary results indicate that the research project has already increased considerably Oklahoma's known sources of quality aggregates for highway construction.

• OKLAHOMA, like other States, is concerned with the increasing problem of the supply of quality aggregates. In Oklahoma there are some localities where the supply is abundant, while there are others where the known sources of supply are limited and becoming exhausted. This situation often requires shipping of quality aggregates long distances and gives rise to the cost of aggregates. The cost of aggregates is high and will continue to increase as the present supply diminishes. As a result of this increasing problem, the Oklahoma Department of Highways initiated a research project, titled "Oklahoma Materials Inventory Research Project," in the early part of 1958 in an effort to determine the availability of materials from known sources and to develop new sources of highway construction materials. The project is being operated in cooperation with the U.S. Bureau of Public Roads.

Construction materials are being located throughout the State, their quantities estimated, and the materials classified for possible use in highway construction. Material sources located and estimated quantities are being catalogued. This information is made available for use in future highway construction projects.

The research procedure includes five major phases, as follows:

1. Library study.
2. Processing of existing data.
3. Field data and sampling.
4. Laboratory testing and analysis of materials for possible use.
5. Consolidation of data and final report.

The project began in June 1958 and the following had been accomplished to December 1962.

Paper sponsored by Committee on Surveying, Mapping and Classification of Soils.

LIBRARY STUDY

Library study consisted of assembling existing records of previously located material sources within the highway department's materials laboratory and in a publication prepared by the Oklahoma Emergency Relief Administration in 1934. These existing records covered a period of 25 years and are as follows:

1. Active and inactive project files of the soils section covering the period 1949 to 1959, inclusive.
2. Ledger files maintained by the physical section covering the period 1936 to 1959, inclusive.
3. A book prepared by the Oklahoma Emergency Relief Administration in 1934, titled "Construction Materials of Oklahoma." This is the same as the Oklahoma State Mineral Survey of 1934-1936.

PROCESSING OF EXISTING DATA

All locations of material were listed by county, legal description, and when available, laboratory file number, project number, and the date they were sampled and tested.

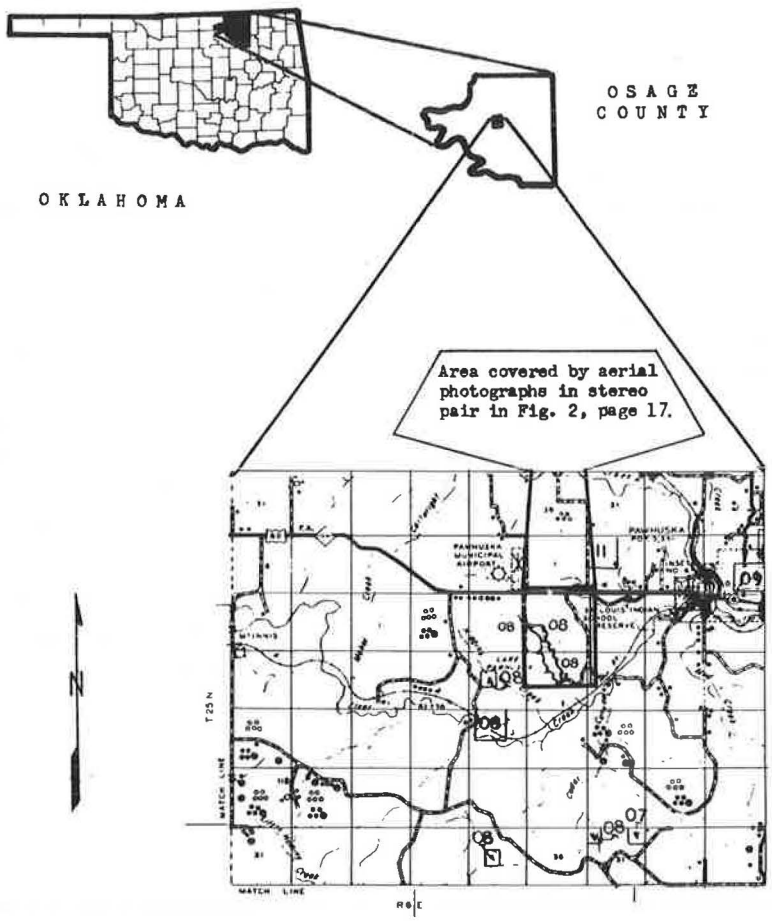


Figure 1. Portion of materials inventory map of Osage County, Oklahoma.

This listing was published and titled "Oklahoma Materials Inventory Research Project Potential Material Sites," and dated February 1960. The publication was made available to personnel of the department and sold for the cost of publishing to individuals outside the department.

Material locations plotted by type of material on sectionalized county maps were prepared and published. These maps were titled "Oklahoma Materials Inventory Research Project Potential Material Sites," and dated February 1960. The material locations were plotted on the maps by the use of a numerical code number for each particular type of material within the quarter of the section in which the material was located. An appropriate legend or explanation appears on each county map explaining the code number and type of material (Fig. 1)

One set of similar maps, but using color symbols instead of the numerical code, was prepared for use within the department only.

The numerical code number and color symbol established for each type of construction material are as follows:

Numerical Code Number	Type of Material	Color Symbol
01	Anhydrite	Purple X
02	Caliche	Olive drab green X
03	Chert	Blue with black lines
04	Conglomerate	Yellow with red dots
05	Dolomite	Light green (bice green)
06	Granite	Blue with pink lines
07	Gravel	Blue
08	Limestone	Crimson red circle
09	Sand	Yellow
10	Sandstone	Brown
11	Suitable soil	Yellow with black X
12	Suitable soil and sandstone	Yellow with black X and brown +
13	Gravel and sand	Yellow with blue lines
14	Caliche and sand	Yellow with olive green drab X
15	Asphalt sand (natural)	Circled A in black color
16	Rip rap	Black circle with RR in center with appropriate color symbol

The materials were grouped according to their usability, and plotted by type of material on three different sectionalized State maps: one map for fine and coarse aggregate, one for soil suitable for stabilization, and another for rock suitable for rip rap material.

Transparent overlays were made for the fine and coarse aggregate and soil suitable for stabilization maps. These overlays facilitated a correlation of the plotted locations of material with a geology map and a soil association map. The overlays are of the same scale as the Geologic Map of Oklahoma and the Oklahoma Soil Association Map.

The existing material records were used to determine the availability of material from known sources, to indicate areas where there is a scarcity of material, and to serve as a guide for locating new sources of material.

The following tabulation indicates the type of material and the number of material locations obtained from existing material records and the source from which they were obtained.

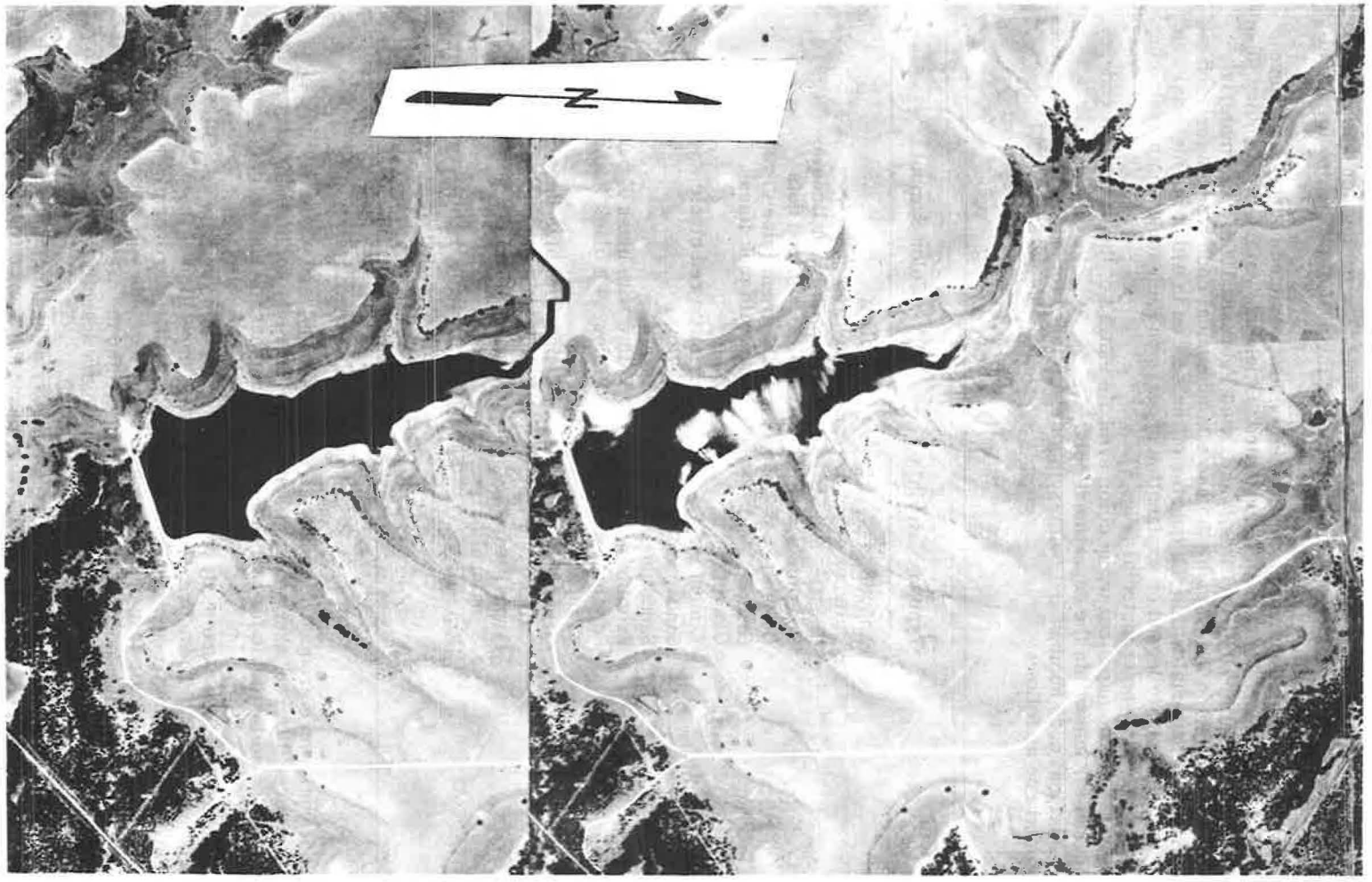


Figure 2. Aerial photographs in stereo pair of Section 12, T25N, R8E, and portions of Sections 11, 13, 14, T25N, R8E.

Type of Material	Oklahoma Emergency Relief Survey	Laboratory		Total No. Locations
		Soils Section	Physical Section	
Caliche	37	15	33	85
Chert	0	0	2	2
Conglomerate	0	0	2	2
Dolomite	0	0	33	33
Granite	0	2	35	37
Gravel	762	253	645	1,660
Limestone	9	118	204	331
Sand	552	68	373	993
Sandstone	11	34	203	248
Suitable soil	0	711	0	711
Sand and caliche	3	0	0	3
Asphalt sand (natural)	5	0	0	5
Rip rap	0	0	365	365
	1,844	1,208	1,895	4,947

FIELD DATA AND SAMPLING

This phase of the project involved three familiarization courses, a series of preliminary field investigations establishing a reconnaissance survey procedure, and scheduling the reconnaissance survey.

Familiarization Courses

The familiarization courses (Earth Resistivity Apparatus, Aerial Photo Interpretation, and Soils Mapping and Identification) were conducted by the Bureau of Public Roads and the Soil Conservation Service.

Earth Resistivity Apparatus.—R. Woodward Moore, Bureau of Public Roads, Washington, D. C., who works with the earth resistivity apparatus, visited the Materials Research Branch to teach the operation of the apparatus and how to analyze the data obtained. The equipment has not been purchased for use on the project.

Aerial Photo Interpretation.—An aerial photo interpretation school was conducted by Jesse R. Chaves of the Bureau of Public Roads, on July 15-22, 1959. The primary objective of the school was to familiarize personnel with techniques used in aerial photo interpretation to locate suitable materials used in highway construction (Fig. 2). Aerial photo interpretation has proved to be one of the more important as well as expedient means for a sufficient and thorough method for locating materials and an aid in estimating their quantities.

Soils Mapping and Identification.—A soil mapping and identification school was conducted by the Soil Conservation Service. The information acquired from this school was useful for the identification of soils and a knowledge of the terminology used with Soil Conservation Service Maps.

Preliminary Field Investigations

A series of preliminary field investigations was conducted in different areas of the State to establish a definite procedure for field reconnaissance surveying, to determine the accuracy of existing material records and of aerial photo interpretation, and to serve as a training program in identifying the different types of construction materials in the field.

A coded numbering system was established to enable each location containing material to be assigned a file number. By assigning a file number to each, it enabled the filing of these locations systematically and facilitated reference for detailed information. It also made it possible to record these locations by data processing machines. This file number, assigned by the reconnaissance party while in the field, is coded to indicate consecutively the county, type of material, site number, and the legal description of the location.

For example: File Number 01-05-09-07-18-24

The first two digits indicate the county. 01, Adair County

The second two digits indicate the type of material. 05, Dolomite

The third two digits indicate the site number. 09, the ninth dolomite location in Adair County

The fourth two digits indicate the section number. 07, Section seven

The fifth two digits indicate the township. 18, Township 18 north

The sixth two digits indicate the range. 24, Range 24 east

Field Reconnaissance Survey Procedure

The field reconnaissance survey procedure was divided into three segments (office preparation, field reconnaissance, and recording of information).

Office Preparation. --Office preparation included aerial photo interpretation, study of soil and geology maps, study of the existing materials, and gathering of any miscellaneous, pertinent data concerning the area to be surveyed.

With a knowledge of the geology and soils within specific areas, the potential locations of aggregates were determined by the technique of stereoscopic examination of aerial photos. The data contained within the existing material records were correlated with soil and geology maps to determine the availability of material from known sources. A study of the data indicated where there was a scarcity of material and served as a guide for locating new sources of material.

Field Reconnaissance. —Field reconnaissance included the investigation of areas that had been located during office preparation and from observation while in the field. Soil and geology maps, the data contained within the existing material records, and aerial photos were taken into the field for reference.

When material was located in the field, reference to soil and geology maps and aerial photos of the area usually denoted additional material locations.

Sand and soil suitable for stabilization were investigated with hand auger with a maximum depth of 12 ft or direct observation where possible.

Gravel was investigated by direct observation when possible and, if necessary, the area was noted to be extensively investigated by power drilling methods later.

Rock, such as sandstone and limestone, was investigated by direct observation of the outcrop, or if necessary, the area was noted to be extensively investigated with power drilling methods later.

An estimate was made as to the suitability of the material for specific uses. This was only an estimate based on personal judgment and confirmed by laboratory testing.

An estimate was made as to the quantity of material available. When it was impossible to make an estimate of the quantity, but it was obvious that more than 20,000 cu yd of material were available, the site was designated as having an "abundant amount," or if it was obvious that less than 20,000 cu yd were available, the site was designated as having a "limited amount."

Recording of Information. —Recording of the information was completed by the survey party in the field at the material site. All information was recorded on the reconnaissance field survey data sheet (Fig. 3).

Schedule for Reconnaissance Survey

A great deal of study was required to determine areas which best met the needs of the highway department. The first areas selected were, primarily, areas where material was more critically demanded due to proposed construction rather than areas of various degrees of scarcity.

A program of proposed construction projects was introduced by the department in

November 1959. The program included the interstate system and one hundred various extents of proposed construction of primary and secondary roads throughout the State. Reconnaissance survey was scheduled for these localities of new construction and has been completed.

The area surveyed for the proposed construction was limited to ten miles each side of the centerline if there was a scarcity of material. If the quantity of material was abundant in a particular locality, only the amount required for the proposed construction was located.

The schedule for reconnaissance survey that is presently being used is based on a study of the Oklahoma Department of Highway's Roadway Sufficiency Rating Report of 1960. The extents of roadway with a basic sufficiency rating of 79 or less were listed by county, by the total linear and vehicle-miles of State highways, the total of linear and vehicle-miles of U.S. highways, and the combined total of linear and vehicle-miles of State and U.S. highways occurring in the county. The vehicle-miles were determined by the product of the average number of vehicles traveling the extent of roadway per day

Form D-1 June 1, 1959
Materials Inventory
Research Project
Revised 5-20-60

RECONNAISSANCE
FIELD SURVEY DATA SHEET

FILE NUMBER 57-08-04-12-25-08

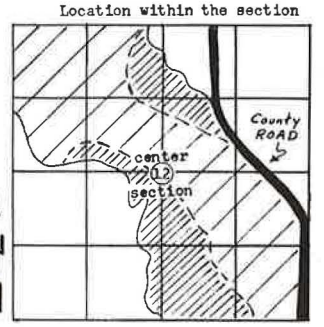
DATE 6/8/62

SURVEYED BY Mitchell Smith

LOCATION SW¼SE¼/S½SE¼NW¼/E½NE¼NW¼ Sec. 12 T 25N R 8E

DESCRIPTION OF LOCATION The area is located 2 miles west and South of Pawhuska, Oklahoma immediately North and East of Lake Pawhuska. The area is not Cultivated and is being used as Pasture.

Location within the section



POSSIBLE USES: SUBBASE ☐ BASE ADMIX ☒ CONCRETE SAND ☐
CONCRETE AGGREGATE ☒ RIP RAP ☒ SOIL ASPHALT ☐
SOIL CEMENT ☐ HOT SAND ASPHALT ☐ SAND CUSHION ☐
ASPHALT SURFACING ☒ OTHER

RATING OF THE MATERIAL: GOOD ☒ FAIR ☐ DOUBTFUL ☐

ESTIMATED QUANITY OF MATERIAL: ABUNDANT ☒ LIMITED ☐

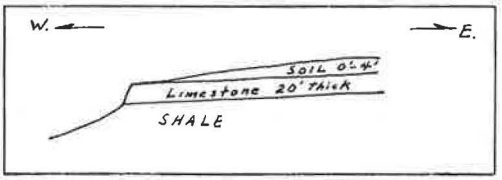
ESTIMATED QUANITY OF MATERIAL: 2,700,000 cu. yds.

DEPTH OF OVERBURDEN 0-4 ft. DEPTH OF MATERIAL 20 ft.

DESCRIPTION OF OVERBURDEN Soil Overburden ranging From 0 feet to 4 Feet in depth where Material probably would be guarried, and increases with depth away from the exposure of limestone.

DESCRIPTION OF MATERIAL Limestone - Approximately 20 feet thick. The limestone is very hard and Dense; Blue-Gray in Color. The limestone is deposited in layers ranging From one to two feet thick with vertical jointing being Prominent. Material that would be detrimental if used with the limestone for Concrete Aggregate, is present in the jointings and seams.

CROSS SECTION OF THE AREA (Give dimensions):



AERIAL PHOTO NO. DWK-12N-11? 9/22/54

SAMPLE TAKEN ☒ YES ☐ NO

LAB. TEST NO. 63964

REMARKS The detrital material occuring in the jointings and seams of the limestone must be removed before the limestone is used for concrete aggregate. The limestone must meet Oklahoma Dept of Highways specifications before used. The limestone is named the Deer Creek limestone.

*File Number - The file number indicates, consecutively, the county, the type of material, the pit number, and the legal description of the area.

TYPE OF MATERIAL NUMERICAL CODE

Anhydrite - 01	Congl't. - 04	Gravel - 07	Sandstone - 10	Gravel and Sand -13
Caliche - 02	Dolomite - 05	Limestone - 08	Suitable Soil - 11	Caliche and Sand -14
Chert - 03	Granite - 06	Sand - 09	Suitable Soil & Sandstone - 12	Asphalt Sand -15
				Rip-rap -16

*EXAMPLE OF FILE NUMBER: 01-05-09-07-18-24

First two digits - 01 the county.....Adair County (Refer to County Code System)
Second two digits - 05 the type of material.Dolomite(Refer to Type of Material code no.)
Third two digits - 09 the pit number.....9th dolomite pit in Adair County
Fourth two digits - 07 the section.....Section no. 7
Fifth two digits - 18 the township.....Township 18 north
Sixth two digits - 24 the range.....Range 24 east

Figure 3.

and the mileage length of the extent of roadway. Approximately 5,000 linear miles of various extents of highways are listed in the present reconnaissance schedule. The reconnaissance survey is scheduled to give priority to counties having the largest total of vehicle-miles per day with a sufficiency rating of 79 or less. If a particular portion or complete county has previously been surveyed, that area has been eliminated from the schedule.

LABORATORY TESTING AND ANALYSIS OF MATERIALS FOR POSSIBLE USE

Laboratory testing pertaining to the field reconnaissance surveying has been kept to a minimum. The material was judged by experienced personnel who conducted the field reconnaissance survey. Samples of borderline materials were obtained and laboratory analysis made to determine their suitability. Material located by reconnaissance survey methods was considered only as potential material and laboratory analysis was required before the material was used.

CONSOLIDATION AND FINAL REPORT

The final report on the project is only in a prospective period at this time, but it will probably be used in conjunction with previously published data and will include the availability of materials within the total area of the State.

A progress report of potential material sites was published in April 1961. The publication is titled "Oklahoma Materials Inventory Research Project Verified and Non-Verified Potential Material Sites, April 1961 Edition." The publication included potential material sites located during the library study phase of the project, which are termed non-verified, and potential material sites located during reconnaissance survey, which are termed verified.

All the material sites were recorded by electronic data processing machines. Pertinent information relating to each listed material site was published, such as the county, type of material, pit number, location (legal description), usability, quantity, depth and type of overburden, owner (private, commercial, or government), laboratory number and date sampled, and if the material site was verified or not verified.

Three maps have been prepared from the results of the data obtained from the reconnaissance survey. The maps indicate the geographic location of potential material sites for a particular type of highway construction. The maps designate, respectively, materials suitable for hot sand asphalt base course construction, stabilized aggregate base course construction, and coarse aggregate for portland cement concrete construction. A radius of 15 miles is drawn around the material sites. The radius represents an economically feasible distance allowed for the hauling of the material, and indicates that particular type of material is available within its boundaries. Copies of these maps have been made and distributed to the various branches within the highway department. As more data are obtained from field reconnaissance, the maps will require revision. This location of additional material sources could reduce the maximum haul below the 15 miles used at the present time.

Approximately 21,000 sq mi or 31 percent of the total area of the State has been surveyed since the project was initiated. The areas surveyed are indicated geographically on a sectionalized State map, titled "Reconnaissance Survey Work Record." Approximately $54,000 and 85 man months of work have been used to date.

ACKNOWLEDGMENTS

To conduct a research project requires the willing cooperation, support, and contributions of several people with knowledge and experience in various fields of study.

The author gratefully acknowledges the supervision of R.A. Helmer, Research Engineer. His devotion and wisdom in highway research and his distinguished work in the Oklahoma Department of Highways are reflected in his continued concern that the results of research by his staff be made available to all.

Acknowledgment is in order for the research personnel who are contributing their efforts to the project. Also, appreciation is extended to the U.S. Bureau of Public Roads, for without their cooperation and advice, the project would not be possible.